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Reconditioning and hardening of mining equipment hydraulic cylinder working surfaces by using of double-electrode cladding

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Abstract. For high-performance and high-quality reconditioning of the working surfaces of the hydraulic cylinders of mining equipment, technology is required that allows you to recondition the surface of the part that meets high requirements for accuracy of shape, hardness and roughness. There are several approaches to obtain the required properties. Comparative overview of the specifics of various approaches showed that arc cladding is the most effective and easiest way to recondition the geometric shape of a part applying to mining industry. It is interesting to obtain a weld metal with the structure of metastable austenite, which special properties allows to reach needed hardness and roughness of the cladded layer's surface by subsequent surface rolling with plastic deformation. Unfortunately, to obtain the structure of metastable austenite it is needed low dilution rate of the base metal in the cladded metal, that is the reason to realize two layers cladding, which significantly reduces productivity of the method. In order to reduce the required number of cladded layers and obtain the structure of metastable austenite already in the first layer it could be applied multi-electrode processes – double-electrode cladding.

1. Introduction

One of the types of mining equipment is shaft lining. A particularly critical element is hydraulic cylinders that lift and maintain the face rock. The peculiarity of the operating conditions of hydraulic cylinders is determined by the difficult conditions of an environmental severity, the chemical activity of mine water, variable dynamic and shock loads from the falling rock. The main reason for the failure of the hydraulic cylinders of the mine lining is a violation of the tightness of the rod sealing system due to the following defects of the rod working surface: seizures, nicks, corrosion, Figure 1.

Figure 1. a – seizurs; b – nicks; c – corrosion [1].

2. Main part

In order to increase the service life of the hydraulic cylinder and increase the resistance of the rod to the occurrence of unacceptable defects, requirements are imposed on the working surface of the rod for high-accuracy geometric shape, hardness of about 55÷60 HRC and roughness of not more than Ra =0.4 [2].

The production of new parts for hydraulic cylinders and their transportation to the places of mining operations leads to large material and time costs. Parts that fail, in 70% of cases are subject to reconditioning, therefore, the reconditioning of parts of hydraulic cylinders of mining equipment is a main priority [3–5]. To recondition the rod of the hydraulic cylinder, there are several approaches. A comparative review of the specifics of various approaches as applied to reconditioning the working surface of the rod of the shaft lining, showed that arc cladding is the most effective and easiest way to recondition the geometric shape of a part.

To obtain the required properties of the working surface, it is interesting to obtain a weld metal with the structure of metastable austenite [6]. With this structure, the special properties of the cladded metal are known – hardening under the influence of external deformation loads. Based on the above described property – strain hardening – it is possible to apply the technology of surface rolling with plastic deformation [7] (hereinafter referred to as SPD) after cladding and lather machining, which will increase the hardness of the working surface of the cladded metal to 55 HRC, which is required for rods. With SPD, the effect of smoothing roughness on the metal surface is also known, which leads to a decrease in roughness. This phenomenon makes it possible to obtain the surface roughness $Ra \leq 0.4$ required for rods by lather machining of cladded layer with subsequent SPD. The experiments showed that such properties are obtained only in the second cladded layer [7], Figure 2, 3.

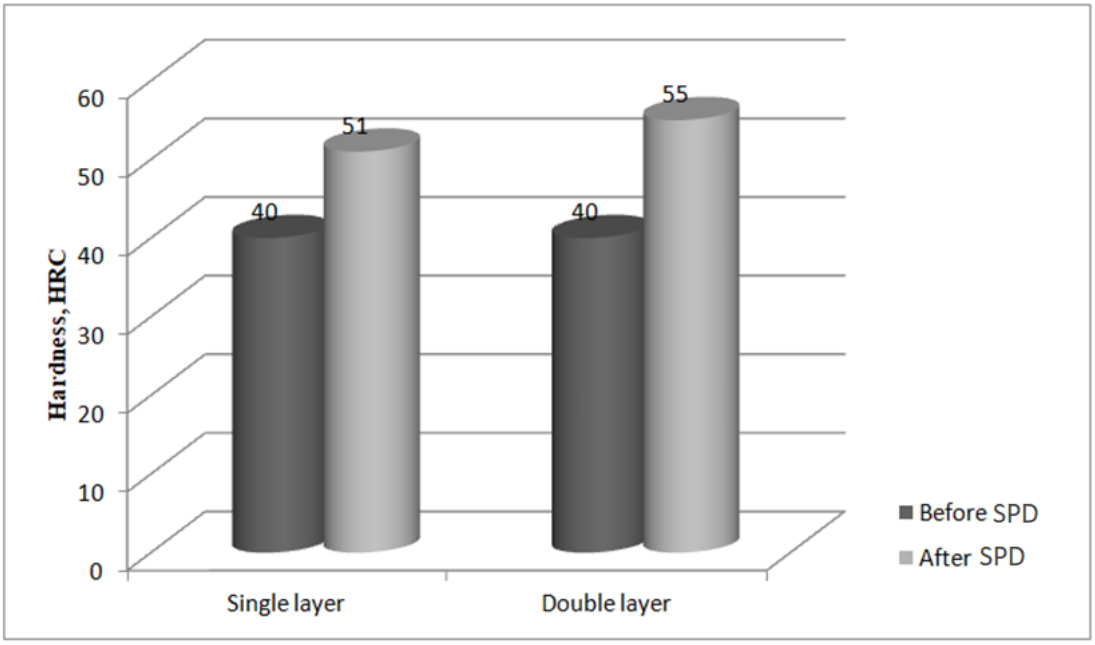

Figure 2. Surface hardness depending on the number of cladded layers [7].

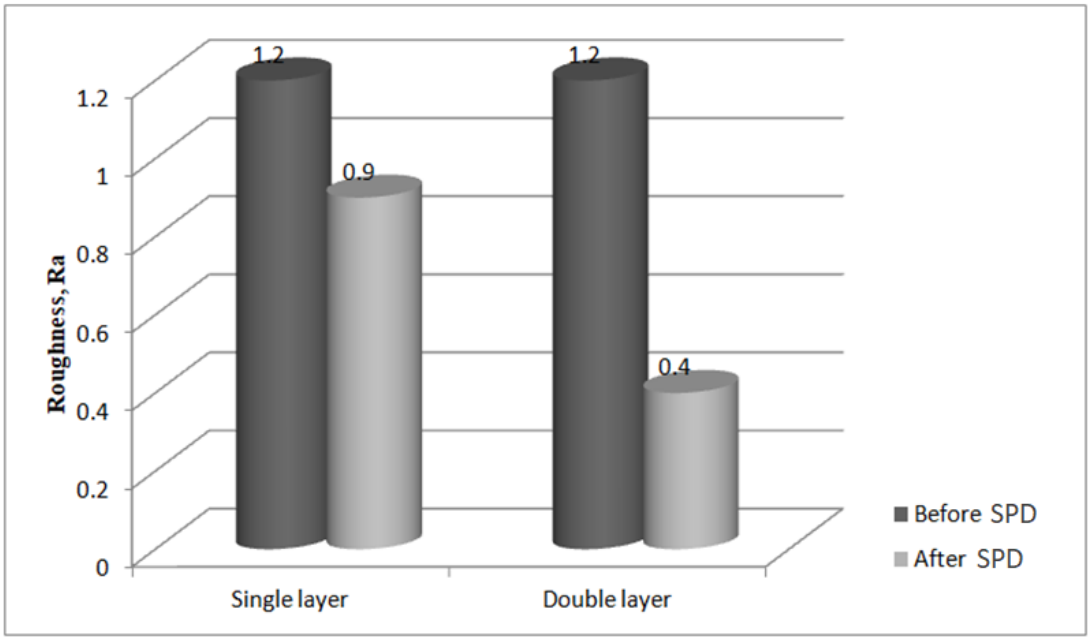

Figure 3. Surface roughness depending on the number of cladded layers [7].

An increase in the number of cladded layers significantly reduces the productivity of the process. The simplest and most relevant way to increase productivity is to use multi-electrode processes [8]. Therefore, as an option to increase the cladding productivity, it is advisable to apply the method of double-electrodecladding [9], which can provide low dilution rate of the base metal in the cladded metal – about 12 v%. In order to reduce the required number of cladded layers and obtain the structure of metastable austenite already in the first layer, a schematic of the process of double-electrodecladding of a cylindrical workpieces shown in Figure 4.

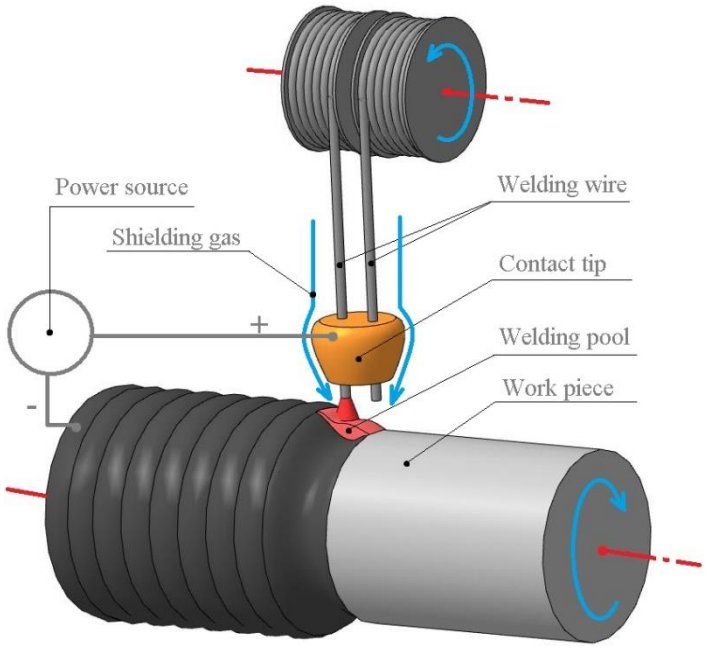

Figure 4. A schematic of the process of double-electrodecladding of a cylindrical workpiece.

3. Conclusion

The use of double-electrodecladding with metastable austenite followed by surface rolling is the most preferable initial option for further research with the aim of increasing the productivity of reconditioning of the working surfaces of hydraulic cylinders in the mining industry.

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